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(54) IMPROVEMENTS RELATING TO THE REINFORCEMENT OF VEHICLE TYRES

(71) We, N. V. BEKAERT SA., a Belgian Body Corporate of Zwevegem, Belgium, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the reinforcement of vehicle tyres.

It is known that the presence of a steel reinforcing layer about the periphery of a tyre between the carcass and tread portions thereof has many advantages. It is also known that advantages are obtained when the steel cords in the reinforcing layer are laid at a very small angle with respect to the meridian plane of the tyre. For instance, greater stability on the road may be obtained. These advantages are better the smaller the angle, so that it is preferable to apply the cords parallel to one another in such a manner that the angle is zero°. It is not possible to apply a reinforcing layer having the width of the carcass, which ply is provided with a number of parallel steel cords, because this will lead to splicing problems where the two ends of the ply have to be connected to each other.

It has thus been proposed to apply a single steel cord by wrapping this cord around the carcass. However, this method of applying a steel cord reinforcement for obtaining reinforcing layer has disadvantages in that it is difficult to obtain equal spacing between successive convolutions during the wrapping operation, as the carcass surface has a curved shape, and further it is a cumbersome operation to wrap one cord on the carcass surface.

The use of a reinforcing strip including a plurality of continuous cords thereon or embedded therein is also known. Such a strip can be formed in any conventional manner, for instance by extrusion or calendaring.

However, when using a reinforcing strip provided with a plurality of cords, the problem arises that the cords will not be subject to equal elongations when the strip

is placed on the curved surface of the carcass. In such conditions, some of the cords may be loaded to undesirably high levels.

According to the invention there is provided a method of forming a reinforcing layer in a tyre, comprising winding a reinforcing strip around the carcass of the tyre at a small angle to the meridian plane thereof so as to form a series of adjacent convolutions, said reinforcing strip being of resilient material having a plurality of continuous reinforcing members running lengthwise thereof, each of said reinforcing members being such that, at a load of 10% of its breaking strength, it undergoes an elongation of at least 0.5%.

Preferably the reinforcing members are made of metal wires, preferably steel wires, though conceivably they could be formed from a synthetic material such as a polyamide.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:—

Fig. 1 is a partial section through one side of a tyre carcass, showing a reinforcing strip wound around the periphery thereof;

Fig. 2 is a stress/strain curve showing the elongation characteristics of a steel cord in a conventional reinforcing strip, and of a steel cord in a strip for use according to the present invention;

Fig. 3 is a diagrammatic view showing how a strip is wound onto a tyre carcass;

Figs. 4a, b, c and d show different ways in which the strip may be laid on the carcass and

Fig. 5 shows a section through a tyre with a reinforcing layer formed from a strip.

Referring to figure 1, the steel cord in position B has to be wrapped around a greater periphery than the steel cord in position A, so that the cord in position B, with the same initial length as the cord in position A, will undergo greater elongation, or is loaded to a greater extent.

As shown in Figure 1:—
the periphery of the cord in position A
is given by πD ; and
the periphery of the cord in position B is
given by $\pi(D+2\Delta)$, so that the elongation
between a cord in the area B and a cord
in the area A is

$$\pi(D+2\Delta) - \pi D = \pi 2\Delta.$$

Thus there is a relative difference of

$$\frac{\pi 2\Delta}{\pi D} \text{ or } \frac{2\Delta}{D},$$

so that the cord in the position B must
undergo an elongation of

$$\frac{2\Delta}{D}.$$

This relative difference or elongation is
dependent upon the diameter D , the width
 b of the strip, and the radius of curvature
of the carcass.

A typical example for an aircraft tyre is as
follows:

diameter $D=100$ cm
width b of the strip $=1.5$ cm
greater value of $\Delta=0.75$ cm.

Thus the cord in position B should
undergo an elongation of

$$\frac{2\Delta}{D} \times 100 = \frac{1.5 \text{ cm}}{100 \text{ cm}} \times 100\% = 1.5\%.$$

Referring now to figure 2, load-elongation
characteristics are shown for two different
steel cords, I and II, cord I being conven-
tional and cord II being for use according to
the invention.

When using cord II, to obtain the desired
elongation of 1.5%, the cord in position B
only undergoes a load of 2.5 kgf. However,
when using cord I, to obtain the desired
elongation of 1.5%, the cord in position B
undergoes a load of 70 kgf.

It is clear that cords II are still able to
take up high loads during normal use, since
they only undergo a small percentage of their
breaking strength, or a small load, whilst
being wound around the carcass. However,
cords I have already taken up more than 70%
of their breaking strength during the winding
of the strip around the carcass. Moreover
the winding operation of a strip provided
with cords I is a very difficult operation as
it is necessary to use a high tensile force to
apply the strip on the carcass, whereas the

winding operation of a strip provided with
cords II only needs a small tensile force.

It can thus be seen that in order to avoid
an undesirably high loading of the cords,
they should be able to undergo a substantial
elongation at a low load compared to their
breaking strength. Thus, in a strip for use
according to the invention, at a stress of 10%
of its breaking strength each cord will
undergo an elongation of at least 0.5%, the
preferred range being 1% to 5%.

The cords should preferably also be such
that during the winding process in a par-
ticular tyre, the load is always lower than
15 kgf, to make the winding process easier.

The strip itself should preferably be be-
tween 5 and 50 mm wide to enable it to be
wound round the carcass, the normal width
required being between 10 and 25 mm. In
order to give a sufficient density of reinforc-
ing cords, preferably at least three cords are
embedded in the strip. The strip may have
any cross section to facilitate laying of it
on the carcass, for instance as shown in
Figs. 4a, b and c.

When manufacturing a new tyre, or re-
treading an old one, the strip is wound round
the carcass at a small angle α to the meridian
plane, as shown in Fig. 3. During this pro-
cess, the tension in the strip and the radius
of curvature of the carcass should be such
that the cords are never loaded to more than
20% of their breaking strength, and pre-
ferably such that the cords are loaded to
less than 10% of their breaking strength.
Adjacent convolutions of the strip may over-
lap, as shown in Fig. 4d.

After the winding operation of the strip
around the carcass, a further rubber layer
is applied to the reinforcing layer formed
from the strip, to provide the tread after the
normal vulcanizing operation. Fig. 5 shows
a section through a tyre, with the strip in
place and the rubber tread shown in dot-
dash outline. The strip can be wound around
the carcass to give one layer, although it is
also possible to wind it around to form more
than one layer, and even to provide one re-
inforcing layer, a rubber layer and a reinforc-
ing layer again. When applying more than
one reinforcing layer the layers will form
opposed angles with the meridian plane, i.e.
the formed angle α of the first layer will be
opposed to the formed angle α of the second
layer.

A strip for use according to the invention
may be used in conjunction with a number
of tyre constructions.

Although in the described embodiment
the cords have been shown as being com-
pletely embedded in the strip, it would be
possible to have them only partially em-
bedded, or even laid on top of the strip.

Suitable high elongation cords or cables
made of twisted strands of steel wires for

use in accordance with the invention are described in our British Patent Specification No. 1,266,383.

WHAT WE CLAIM IS:—

- 5 1. A method of forming a reinforcing layer in a tyre, comprising winding a reinforcing strip around the carcass of the tyre at a small angle to the meridian plane thereof so as to form a series of adjacent convolutions, said reinforcing strip being of resilient material having a plurality of continuous re-
10 forcing members running lengthwise thereof, each of said reinforcing members being such that, at a load of 10% of its breaking strength, it undergoes an elongation of at least 0.5%.
- 15 2. A method as claimed in claim 1, wherein said reinforcing members are embedded in said resilient material.
- 20 3. A method as claimed in claim 1 or 2, wherein said reinforcing members are such that, at said load of 10% of their breaking strength, they undergo an elongation in the range 1% to 5%.
- 25 4. A method as claimed in any of claims 1 to 3, wherein the said strip is from 5 to 50 mm wide.
5. A method as claimed in claim 4, where-
in the said strip is from 10 to 25 mm wide.
- 30 6. A method as claimed in any preceding

claim, wherein said strip includes at least three of said reinforcing members.

7. A method as claimed in any preceding claim, wherein said reinforcing members are formed from steel wires.

8. A method as claimed in claim 7, wherein each said reinforcing member comprises a cord made of twisted strands of steel wires.

9. A method as claimed in any preceding claim, wherein the reinforcing members of the strip are loaded to not more than 20% of their breaking strength during the winding operation.

10. A method as claimed in claim 9, wherein the reinforcing members of the strip are loaded to less than 10% of their breaking strength during the winding operation.

11. A method of forming a reinforcing layer in a tyre, substantially as hereinbefore described with reference to the accompanying drawings.

12. A tyre, including a reinforcing layer formed by a method claimed in any of the preceding claims.

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